VIA MEDICA

ORIGINAL ARTICLE

Folia Morphol.
Vol. 65, No. 2, pp. 116–120

ISSN 0015–5659
www.fm.viamedica.pl

The most common anatomical sites of arterial injury in the extremities: a review of 75 angiographically-proven cases

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[Received 17 January 2006; Revised 31 March 2006; Accepted 31 March 2006]

The incidence of vascular injury has increased worldwide. In an attempt to quantitate the specific arteries most commonly involved in the extremities, we reviewed 75 patients with extremity trauma who were evaluated with angiography (DSA, digital subtraction angiography). The majority of these injuries were related to motor vehicle accidents (93.3%). The mean age of these patients was 28.16 ± 11.14 years, 94.7% of these patients being male. The ratio of upper to lower extremity arterial trauma was 12 to 86. A total of 99 arterial injuries were detected angiographically. Simultaneous injuries to two and three extremity arteries were identified in 13.3% and 9.3% of patients respectively. The most common arteries injured were the anterior tibial, femoral, peroneal, and popliteal arteries. Associated fractures were present in 86.7% of patients. These data may prove useful to the clinician who evaluates post-traumatic injuries of the extremities.

Key words: motor vehicle accident, limb, vessels, traumavariation

INTRODUCTION

The incidence of vascular injury has increased worldwide, primarily as a result of traffic accidents and criminal violence [10, 15]. Vascular injuries of the extremities have been documented as far back as the Greek and Roman empires and undoubtedly occurred prior to these eras [2]. The aim of the present study was to evaluate the mechanism and type of extremity arterial trauma and the anatomical sites of these injuries in a large group with angiographically-proven injuries. In identifying the most common sites of vascular injury to the extremities the data from the present study may aid the clinician in the evaluation of patients following motor vehicle accident injury.

MATERIAL AND METHODS

A total of 75 patients with extremity trauma were evaluated with angiography (DSA, digital subtraction angiography) at the Imams Hospital, Tabriz University of Medical Sciences, Tabriz, Iran from September 2003 to October 2004. This centre is the only angiography facility available in the three northwest provinces of Iran (Eastern Azerbaijan, Ardabil, and Zanjan) and also supplies the major part of the province of Western Azerbaijan. The age and gender of the patients as well as the cause of trauma were recorded. The injured artery/arteries were identified and the type of injury documented. Associated fractures and articular dislocations, if any, were also recorded. Statistical analysis was performed using SPSS

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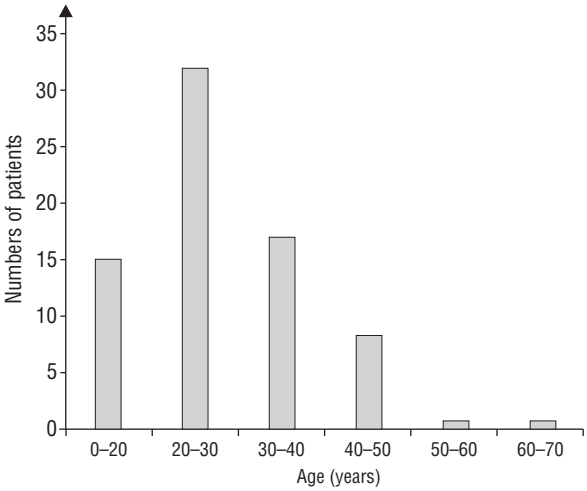

Figure 1. Age distribution of patients with vascular trauma.

software (Statistical Package for the Social Sciences, version 11.0, SSPS Inc, Chicago, IL, USA). A p value of less than 0.05 was considered statistically significant.

RESULTS

The mean age of the patients was 28.16 ± 11.14 years. There were 71 (94.7%) male and 4 (5.3%) female patients. The mean age of the male patients was lower than that of the females (27.9 ± 11.28 years vs. 42.5 ± 20.92 years, p = 0.019). The peak age group for extremity vascular injury was 20 to 30 years, which included 44% of all patients (n = 33) (Fig. 1). Of 75 patients 70 (93.3%) had been involved in a motor vehicle accident, either a motorcycle accident (n = 60, 80%) or a car accident (n = 10, 13.3%) (Table 1). The ratio of upper to lower extremity vascular trauma was 12 to 86. A total of 99 arterial injuries were detected angiographically. Of these, 93 (93.9%) injuries were secondary to a motor vehicle accident. Simultaneous injuries to two and three arteries were evidenced in 11 (13.3%) and 6 (9.3%) patients respectively. The anatomical sites of the injuries are shown in Table 2. Most commonly these involved the anterior tibial artery (n = 29) and the femoral (n = 16), peroneal (n = 15), and popliteal arteries (n = 13). The types of injury are detailed in Table 3. Figures 2 and 3 provide examples of two cases with total occlusion of vessels of the lower extremities following trauma. Complete occlusion and spasm or external compression made up 57 (56.4%) and 37 (36.6%) of these injuries respectively. Associated fractures were present in 65 patients (86.7%), the most common being combined tibial-fibular (n = 36, 55.4%), femoral (n = 19, 29.2%), humeral (n = 5, 7.7%), costal (n = 2, 31%), tibial (n = 2, 3.1%) and combined ulnar-radial fractures (n = 1, 1.5%). Four out of 75 (5.3%) patients had knee dislocations that were associated with popliteal artery injury. Traffic related trauma (motorcycle or car accidents) was more often associated with fractures compared to non-traffic trauma (p < 0.05).

DISCUSSION

Significant gender differences in the incidence of arterial trauma, as seen in our study (94.7% male

Table 1. Anatomical sites of arterial injuries

Injured artery	Number	Percentage	Age (mean ±SD)	Types of arterial injuries
Anterior tibial	29*	29.3	27.14 ± 8.95	CO: 17, S/EC: 12, AVF: 1
Femoral	16**	13.1	26.25 ± 10.93	CO: 5, S/EC: 9, TS: 1, AVF: 1, PA: 1
Peroneal	15	16.2	26.93 ± 7.20	CO: 11, S/EC: 4
Popliteal	13	15.2	36.54 ± 17.27	CO: 11, S/EC: 2
Posterior tibial	12	12.1	27.08 ± 7.65	CO: 7, S/EC: 5
Brachial	6	6.1	24.17 ± 9.85	CO: 5, S/EC: 1
Subclavian	2	2	42.00 ± 24.04	CO: 1, S/EC: 1
Deep femoral	2	2	34.00 ± 15.56	S/EC: 1, TS: 1
Thoracoacromial	2	2	22.00 ± 0.00	TS: 2
Ulnar	1	1	18	S/EC: 1
Radial	1	1	18	S/EC: 1

SD — standard deviation; CO — complete occlusion; S/EC — vasospasm or external compression; AVF — arteriovenous fistula; TS — transection; PA — pseudoaneurysm; *Note that a simultaneous CO and AVF of the anterior tibial artery was seen in one patient with a stab wound; **Note that a simultaneous AVF and PA of the femoral artery were seen in one patient with a stab wound

Table 2. Mechanisms of arterial trauma identified in the present study

Mechanism of trauma	Number of patients	Age (mean ±SD)	Number of involved arteries	Extremity involved (upper: lower)
Motorcycle accident	60	26.6 ± 9.8	82	7:53
Car accident	10	46.7 ± 16.6	11	1:9
Penetrating wound	2	21.0 ± 5.7	2	2:0
Fall	2	19.5 ± 3.5	3	1:1
Industrial accident	1	44	1	1:0

Table 3. Types of arterial injuries

	No. of involved arteries	Percentage
Complete occlusion	57	56.4
Vasospasm or external compression	37	36.6
Arteriovenous fistula	2	2
Transection with active haemorrhage	4	4
Pseudoaneurysm	1	1

vs. 5.3% female), have been reported before. Asirdizer et al. [1] found that over 84% of patients with vessel injury were male, with a peak incidence between 26.0 and 39.7 years, and postulated that this may be attributed to a more active life-style and "aggressive" attitude in this group. In the study of Razmadze [15] only 7.7% of vascular injuries occurred in women.

Nawaz et al. [13] postulated that upper extremity vascular trauma constitutes between 28 and 58% of peripheral vascular injuries. In the study of Menakuru et al. [10] 52% of total arterial injuries were in the upper extremities. Bongard et al. [3] found that 39% of vascular injuries occurred in the upper extremities with 18% of these cases resulting from motor vehicle accidents. Interestingly, Gupta et al. [4, 5] found that vascular injury to the lower extremity was most often due to stab injuries and to the upper extremity to work-related accidents. In our study 12 out of 98 arterial injuries (12.2%) involved upper extremity arteries. It seems that with the increasing number of traffic-related accidents involvement of the arteries of the lower extremity has increased.

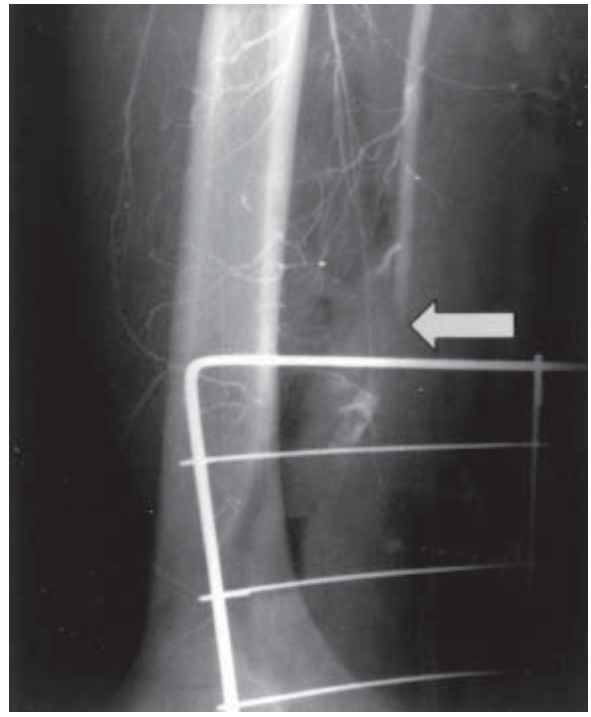

Figure 2. Arteriogram noting distal occlusion (arrow) of the femoral artery in a post-traumatic patient.

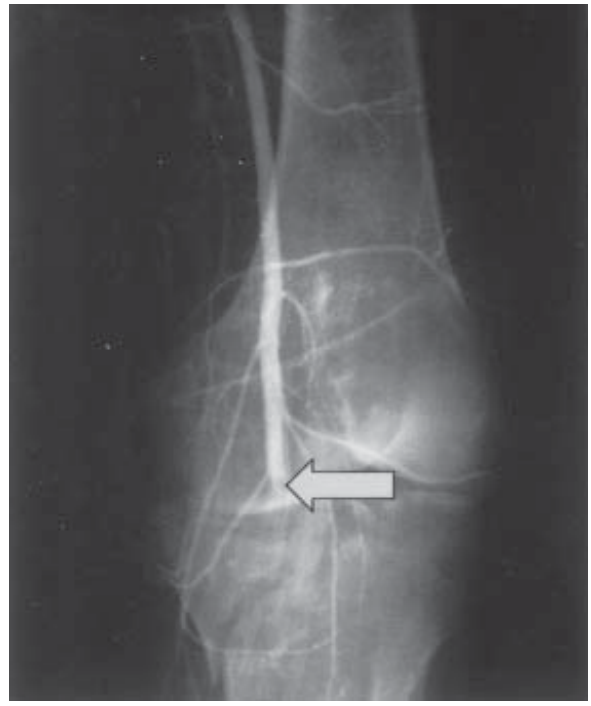

Figure 3. Arteriogram noting occlusion of the popliteal artery (arrow) in another patient following trauma.

In our study 93.3% of trauma was road-traffic related. Motorcycle accidents accounted for 80% of cases. Iran has the highest rate of traffic accidents

worldwide with approximately 200,000 people per year injured in automobile accidents of which 15––25,000 die [12]. Both Humphrey et al. [6] and Koivunen et al. [9] have reported that vascular trauma to the extremities occurs as a result of motor vehicle accidents in approximately 30% of cases. In general the mechanisms of vascular injury show a regional variation dependent on local cultures and laws.

The vascular tree, both arterial and venous, appears to have some limited natural protection from stretching and bending, which results in fewer injuries to the extremity vasculature following blunt trauma [2]. The smooth muscle of the arterial tunica media protects one from both stretch-type injuries and minor puncture wounds, which heal spontaneously in most cases. When an artery is transected, vascular spasm coupled with low systemic blood pressure appears to promote clotting at the site of injury [2]. This partially explains the pre-hospital finding that, in the subset of penetrating trauma, limited or no fluid resuscitation (i.e. increased blood pressure) until arrival at the hospital may improve patient survival and outcome [2].

In the majority of studies the most frequently injured upper and lower extremity arteries have been found to be the brachial and femoral arteries respectively [1]. In our study the anterior tibial artery (29.3%) was the most often injured artery followed by the femoral, peroneal and popliteal arteries (16.2%, 15.6% and 13.1%, respectively). The high percentage of anterior tibial artery injury observed in our study might be explained by the high rate of motor cycle accidents found in our study. This type of trauma might occur by striking the anterior leg on the front shield of a motor cycle with anterior collisions. The number of injured tibial vessels is an important predictor of limb amputation after lower extremity trauma [11]. Menakuru et al. [10] found that the brachial, femoral, and popliteal arteries, in descending order of frequency, were the most commonly injured arteries in the civilian population of Northern India. However, in their study falls from great heights (35%) and automobile accidents (32%) were the most frequent mechanisms of trauma. Asirdizer et al. [1] reported that in Turkey the most frequently traumatically injured arteries were the femoral, popliteal and brachial arteries. These authors postulated that shooting or stabbing in the lower limbs, which is a cultural warning from various organised crime groups, may have resulted in the higher incidence of lower extremity arterial injuries.

Popliteal artery trauma is apparently uncommon; however, we identified 13 such cases. Gupta et al. [4, 5] found only nine patients with popliteal artery injury during a five-year study in Australia, of which eight cases were due to blunt trauma with seven of these resulting from a motor vehicle accident. However, in the United States penetrating trauma and gunshot wounds account for the majority of popliteal artery injuries. In our study all popliteal artery injuries were motor vehicle-related, which is comparable to the observation made by Gupta et al. [4, 5]. Indeed, with impact injury to the lower extremity one would expect a greater incidence of knee dislocation with subsequent popliteal artery injury as found in 16% of the patients in the study of Kendall et al. [8]. However, traction may also be involved with arterial injury following blunt trauma to the extremities [17].

In our study, no injury to the femoral artery proximal to its bifurcation was found. In general, blunt trauma to this part of the femoral artery is rare and only represented by single case reports in the medical literature [14]. The absence of injury to this proximal portion of the femoral artery in our study may be attributed to the high incidence of blunt trauma observed.

Blunt trauma to the subclavian artery is also an uncommon condition. Katras et al. [7] found only six cases of blunt subclavian artery trauma at the East Tennessee State University-affiliated hospitals between 1992 and 1998. All these injuries were complicated by a regional fracture and/or pneumothoraces. We found only two cases of subclavian artery injury that were secondary to blunt trauma from a motor vehicle accident. In both cases there was an associated rib fracture.

Associated fracture or dislocation has been reported in up to 95% of patients with blunt vascular trauma to the extremities [16]. Concomitant orthopaedic and vascular injuries of the lower extremity are associated with a greater rate of limb loss [11]. In our study 86.7% of patients had concomitant fractures, the most common of them being combined tibial-fibular fracture (55.4%). The high rate of combined tibial-fibular fracture and tibial and peroneal arterial injuries is, as previously discussed, probably related to the high incidence of motor cycle accidents that preferentially involve the legs.

By identifying the most common sites of vascular injury in the extremities these data may aid the clinician in evaluation of patients following motor vehicle accident injury.

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